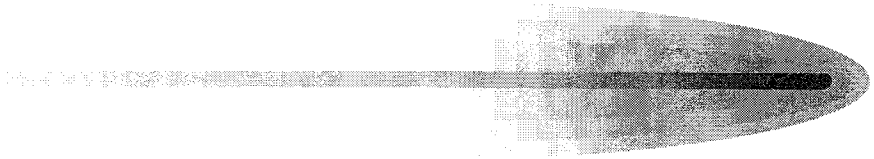

QWIP FPA
in
STRV-1d MISSION

Presented at the
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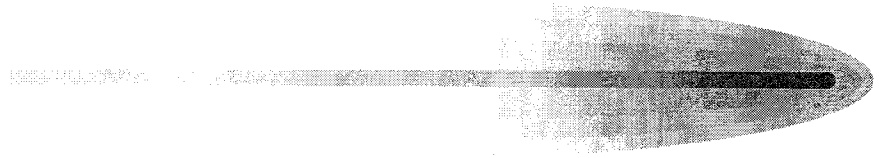
OBJECTIVES

- Demonstrate and assess QWIP FPA uniformity, stability, and repeatability in a space environment
  - Spatial non-uniformity
    - Photo current and dark current
  - Instability
    - Mean photo current, dark current over experiment cycle
  - Non-repeatability
    - Mean dark current
    - Mean responsivity
- Demonstrate QWIP radiation tolerance using QWIP diodes by tracking changes in responsivity.

WHY QWIP

- QWIP complements and extends HgCdTe sensor technology.
- QWIP enables fabrication of large arrays for strategic surveillance.
- QWIP provides long term stability of Responsivity.
- QWIP operates at wavelength longer than 15μ at 40°K.



MISSION

- Primary Mission requirements were:
  - minimum of one year in-space operation, and
  - high proton and electron radiation exposure.

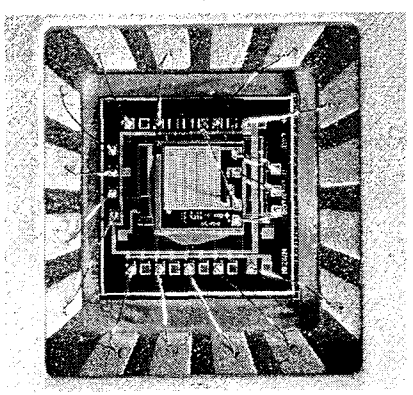
- STRV-1 Mission launches to a geosynchronous transfer orbit (GTO)
  - 620 km by 36000 km at 7.5 degree inclination.
    - provides four transitions through proton and electron belts per orbit.
  - One year mission with potential for extension..

DEVELOPMENT GUIDELINES

- Document design, test and operational requirements.
  - Mil-Std 1540 "Test Requirements for Space Vehicles"
    - "Protoflight" requirements tailored to QWIP mission.
  - DOD-Hdbk-343 " Design, Construction, and Testing Requirements for One of a Kind Space Equipment"
    - Class B requirements tailored to QWIP Mission.
  - Mil-Std-1541A "Electromagnetic Compatibility Requirements for Space Systems"
  - Interfaces negotiated and documented with Spacecraft contractor.
    - Interface Control Document for mechanical, thermal, environmental, power, and electrical interfaces.
    - Software Interface Control Document for spacecraft commanding, data format, and data handling.
- Design and Test Requirements
  - 60 requirements allocated in ICD by spacecraft.
  - 22 requirements derived at JPL.

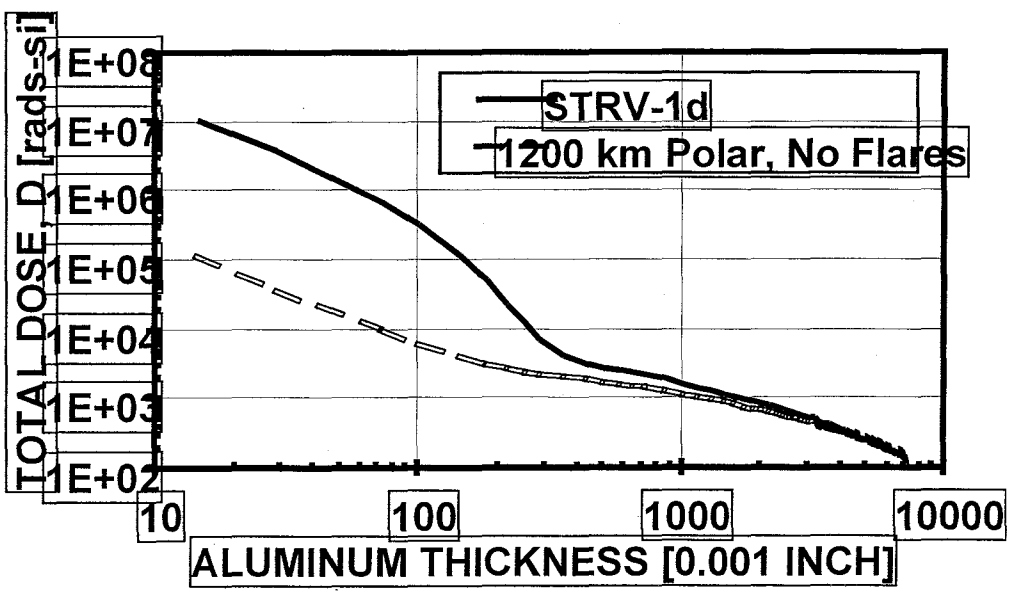
EMI AND RADIATION DESIGN

- EMI Design
  - Radiated and conducted emissions and susceptibility.
  - Radiated susceptibility to 40 V/m fields at 2269.5 and 2288.5 MHz.
- EMI Test
  - Measured radiated and conducted emissions during operation.
  - Radiated hardware during operation.



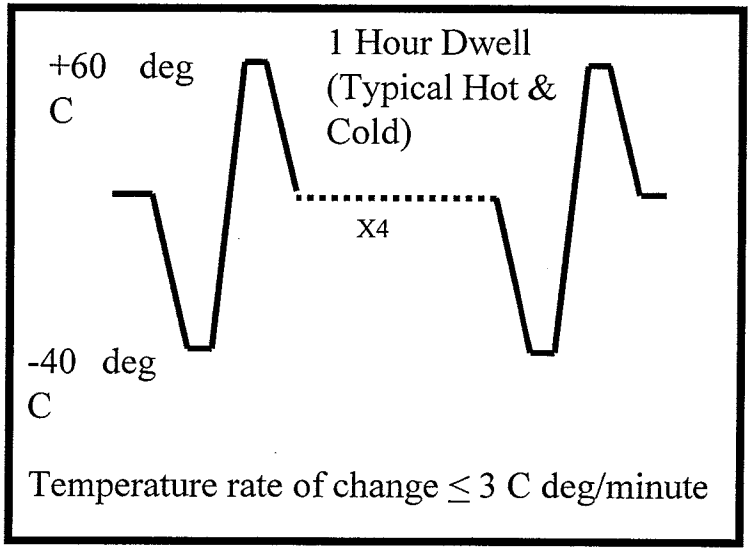
Mother chip is 1.8 mm x 2.2 mm and RADFET is about 1mm x 1 mm.

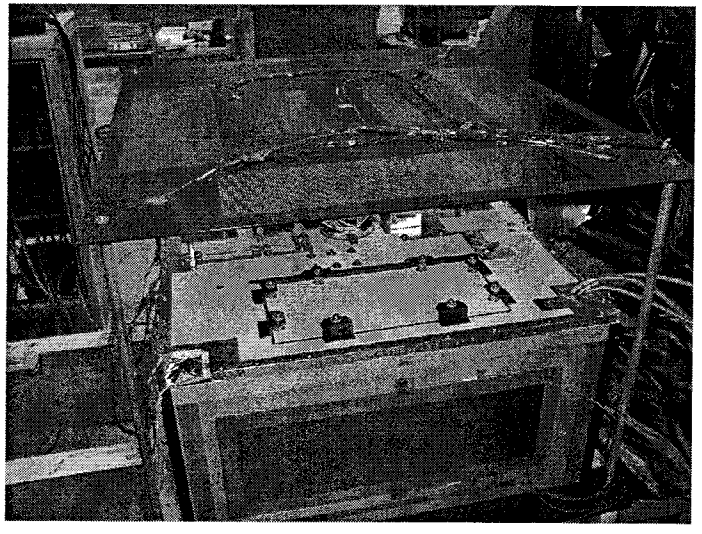
- Radiation Design
  - Electronic parts radiation tolerant to 50 Krads or greater.
  - Support electronics shielded.
  - Data storage in DRAM used triple storage and majority vote.



THERMAL DESIGN AND TEST

- Thermal Design
  - -40°C and +60°C (non-operating or survival limits).
  - -30°C and +50°C (operating limits).
- Thermal Test
  - Completed four temperature cycles in GN2 chamber after fixes validated.
  - Hot and cold starts, and successful operations at hot, cold and ambient temperature verified.
- Thermal-Balance
  - Validated JPL thermal model for flight predicts



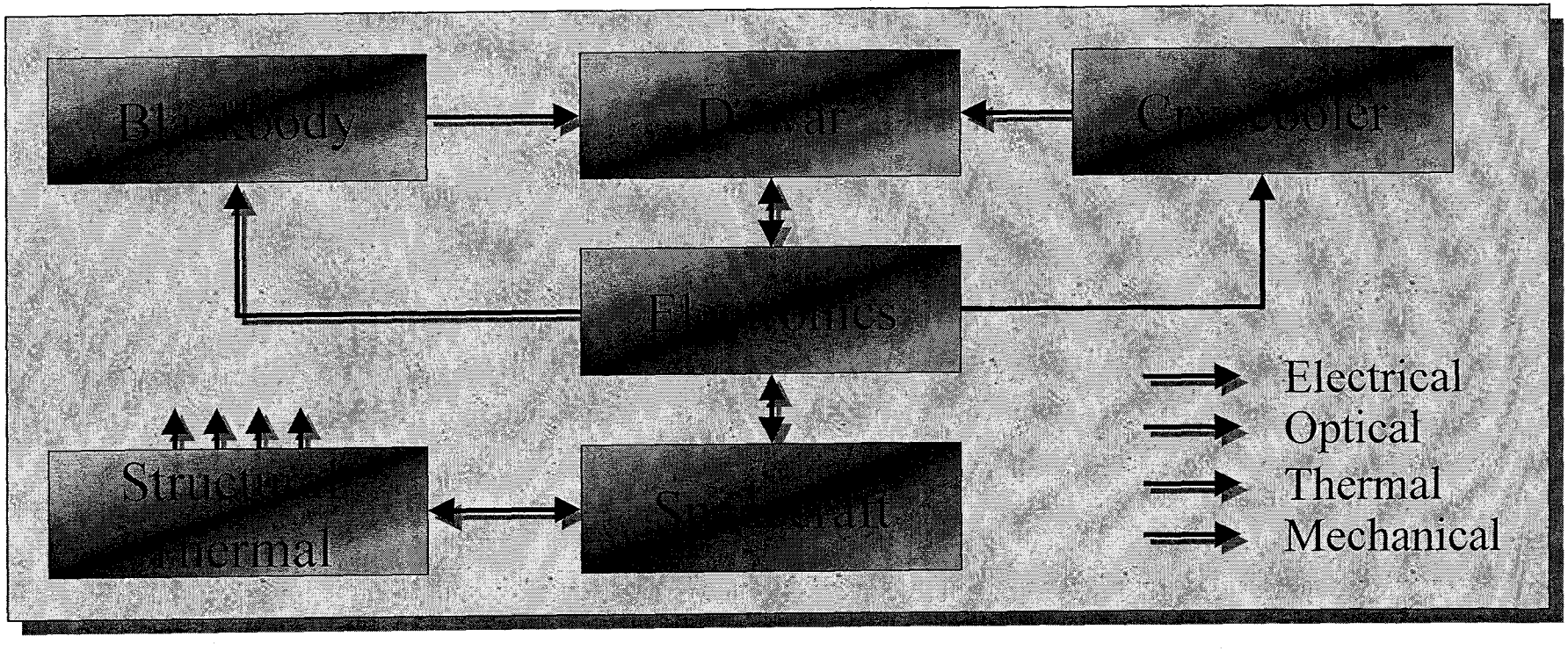


DYNAMIC DESIGN AND TEST

- Dynamic Design
  - Random vibration spectrum developed from spacecraft test response data.
  - Acoustic spectrum derived from Airane 5 Handbook.
- Dynamic Test
  - Electronics Chassis subjected to random vibration only.
  - IDA mounted to MFS Panel subjected to acoustic and random vibration.
  - Random vib-ed in 3-axes, 60 seconds/axis

EXPERIMENT ARCHITECTURE

- The QWIP Experiment has five major subsystems
  - Integrated Dewar Assembly
  - Cryocooler Assembly
  - Electronics Assembly
  - Blackbody Assembly
  - Structural/Thermal Control



INTEGRATED DEWAR AND BLACKBODY

- Dewar
  - Hermetically sealed dewar (minimizes contamination)
  - Cold shield (minimizes non-blackbody flux on FPA)
- Focal Plane
  - Peak response — 11.0 ± 0.2 microns
  - Operating Temperature — 55 Kelvin
  - Array Format — 128 x 128
  - NEΔT @ 380 K blackbody — 1.0 K
  - Integration Time — 3.8 milliseconds
  - Integration Time Range — 0.2 to 25.0 milliseconds (in steps of 0.2)
- Blackbody
  - Temperature Range — $\leq$ 400 K
  - Temperature Stability — ± 0.1 K over 10 minutes
  - Temperature Repeatability — ± 0.2 K from cycle to cycle
  - Emissivity Stability — *± 0.5 % over its life*

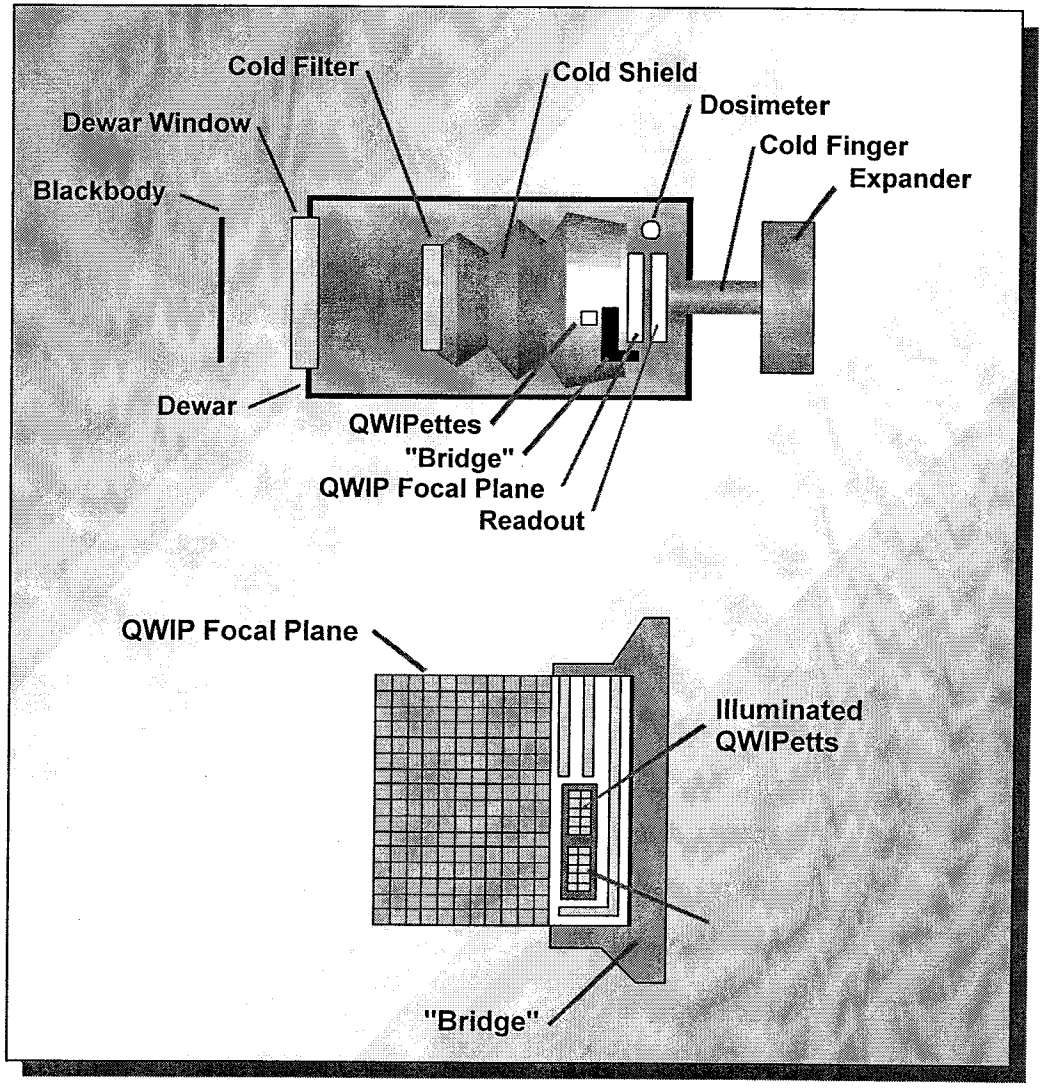
FPA AND QWIPettes

- Focal Plane Bridge
  - Masked Area — *$^1/_3$ to $^1/_4$ of array*
  - Mount QWIPettes — *over the FPA (consistent illumination)*
  - Thermal Interface — *thermally integrated with motherboard*

- QWIPettes
  - Same detector material as FPA (wavelength, response, dark current, etc.)
  - A pair of 200 μm detectors illuminated (increases output signal)
  - Four 200 μm detectors coated with opaque material for dark current signal

DEWAR DESIGN

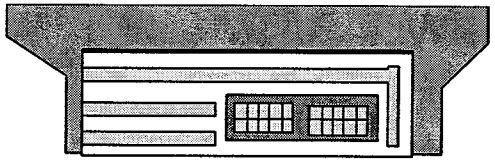
- QWIP Focal Plane Array is 128 x 128
  - 30 to 40 rows are shaded by the "bridge"
  - 5 to 10 rows are in "transition", i.e. partially shaded
  - Remainder of focal plane is illuminated by the blackbody



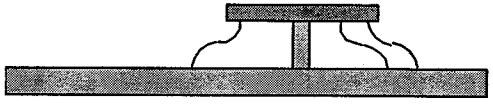
QWIPette DESIGN

- **QWIPette Objective:**
  - *Measure dark current and photo current with discrete readout circuits (much more radiation tolerant than ROIC)*
- **Dark Current Measurement**
  - *Four detectors are wired in parallel to increase signal to noise ratio, provide larger current into readout circuit*
  - *Dark detectors coated with opaque epoxy*
- **Photo Current Measurement**
  - *Two detectors are wired in parallel to increase signal to noise ratio, the two detectors have gratings most similar to QWIP arrays*
- **Temperature Uniformity**
  - *Design ensures both parts of the QWIPettes are at the same temperature*

Top View



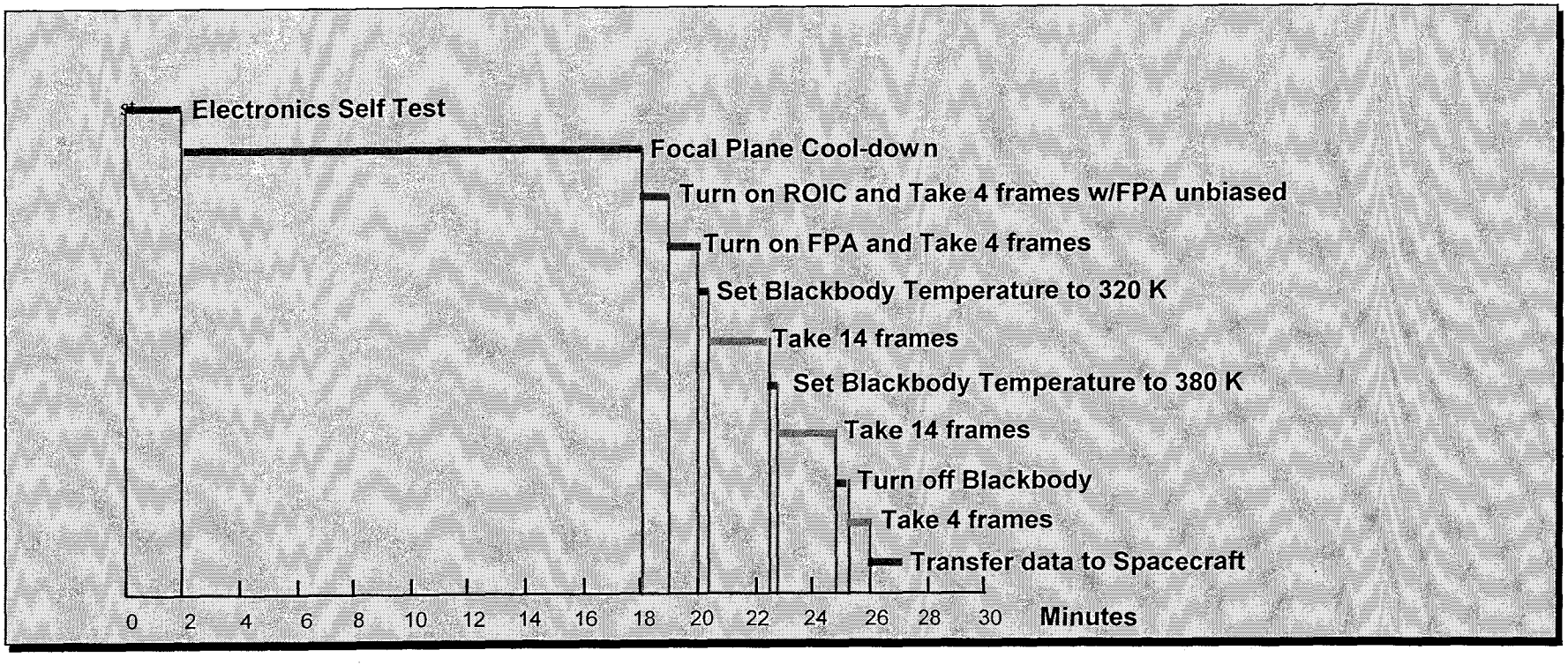
Side View



OPERATIONAL SCENARIO

- Data Collection Scenario
  - Collect 40 frames of Focal Plane Data
    - Collect 4 frames of data from the ROIC with FPA unbiased
    - Collect 4 frames of data from the FPA at 800 μsec and 2 diode reads at 40Hz while viewing ambient conditions (Ambient frames).
    - Turn on blackbody (BB) to T1 (~320K)
    - Collect 14 frames of data from the FPA at 800 μsec and 16 diode reads at 40Hz while viewing the BB at T1 (Data frames).
    - Switch BB to T2 (~380K).
    - Collect 14 frames of data from the FPA at 800 μsec and 16 diode reads at 40Hz while viewing the BB at T2 only (Data frames).
    - Switch BB off.
    - Collect 4 frames of data from the FPA at 800 μsec and 2 diode reads at 40Hz while viewing ambient conditions (Ambient frames).

OPERATION TIMELINE



The Experiment operates every sixth orbit (~ 2.6 days)